Atlantic Ocean Carbon Synthesis Meeting
March 21 - 23, 2007
IFM-GEOMAR
Kiel, Germany

Contents:

1. Background to the workshop

One of the five major objectives of the EU CARBOOCEAN integrated project is the quantification of decadal-to-centennial large-scale Atlantic and Southern Ocean carbon inventory changes. Operationally this implies a need to quantify: "the Atlantic and Southern Ocean carbon sink, and its decadal change, through highest accuracy measurement of the changing inventories of inorganic carbon and carbon-related tracers. Atlantic and Southern Ocean data would then be integrated into a coherent global data base. The ability of prognostic models to represent the observed changes for a reliable now-cast would be assessed against the data-based syntheses." The science delivery associated with this objective is "a large scale assessment of the ocean carbon storage".

The objective of this work-shop was to coordinate progress with compilations of Atlantic carbon data (e.g., CARINA data) being carried out as part of CARBOOCEAN. CARINA was formed as an essentially informal, unfunded project, organized by Ludger Mintrop and Douglas Wallace of Kiel. The result was the assembly of a large collection of useful, previously unavailable data. However no funds were available to allow the data contributors to quality-control these data sets or to work on them. During the last year the CARINA data base has grown significantly. However large the data base is, one key feature of a data set is the internal consistency of data, i.e. an assurance that data from different investigators and programs are comparable and on a common scale. Since the CARINA data base consist of 1st level quality controlled data, a 2nd level quality control needs to be carried out to assure data consistency.

The main goal of the workshop was to start and coordinate the data consistency effort with the cruise data that has been collected during CARINA. Particularly, the goals of the data meeting were to:

- Identify suitable methods for the various regions to perform the 2nd level quality control (QC).
- Discuss and agree on particulars of these methods.
- Discuss potential problems and difficulties of these methods.
- Agree on time schedules and assign specific tasks.
- Discuss and agree on suitable means of communication within the groups.

2. Deliverables: summary

Here is a short summary of what we agreed on to deliver until the CarboOcean meeting in Bremen in December 2007.

The main goal is to deliver:

- A merged and quality controlled data set (CARINA).
- A table with recommended adjustments for each variable and each cruise.
- A data product that is the same as the data set, but with the recommended adjustments applied.

This is the way we will do it:

- X-over analysis. Data to be compared in the deep waters and on density surfaces (except for salinity that will be done on depth surfaces).
- Regional MLR analysis.
- Deviations from regional mean profiles.
- The offsets determined in the first three steps will form the basis for determining recommended offsets.

3. Introduction

The workshop was opened and the goals for the CarboOcean data synthesis effort, as viewed by Toste, were introduced:

- To create a database of carbon related data for the Atlantic, Arctic and Southern Ocean.
- Produce an internally consistent data base that has gone through a 2nd level quality control.
- Bring research groups together that measure CO_2 in the Atlantic.
- Form working groups that cooperate.
- Exchange information concerning CO_2 in the Atlantic.
- Estimate the inventory of anthropogenic CO_2, detect changes in uptake, storage, export, changes in circulation, compare Cant inference methods……..etc i.e. PRODUCE CARBON RELEVANT SCIENCE

To give an overview of the relevant science that could be the outcome of the synthesis efforts, the scientific goals as outlined during the Iceland meeting were briefly recaptured.

<u>Arctic Mediterranean Seas</u>

- Systematic determination of the Atlantic C_{ant} inventory.
- Suitable method of C_{ant} estimation.
- How does C_{ant} enter the region?
- How is C_{ant} transferred afterwards?
- How much is transferred to adjacent basins?
- What is the rate of change?
- Changes in saturation state of carbonate minerals?

- What future measurements do we need?

North Atlantic

- Add the Mediterranean C_{ant} inventory to the global.
- Depth distribution of C_{ant}.
- Variability of oxygen. Drivers.
- Close the C_{ant} budget based on transport and storage estimates.
- Shifts in LSW ventilation rate and effects on C_{ant}.
- Variability of mode waters.
- Ventilation pathways of the sub-polar and subtropical gyres.
- C_{ant} inventory increase, really smaller than the Pacific?
- Is organic carbon important for the carbon budget?
- Feedback of MOC variability on carbon balance

Southern Ocean

- Which is the optimal method to determine C_{ant} in the Southern Ocean?
- Estimate the regional or whole SO C_{ant} inventory, using as many data as possible.
- Compare C_{ant} with CFCs. Any agreements / disagreements?
- Compare observations with models. Sensitivity to changes in circulation / physics.
- Separating C_{ant} from natural DIC changes.

4. The CARINA data

Bob Key gave us an update on the CARINA (Carbon in the North Atlantic) data base. Bob noted that for a large number of cruises there were often incomplete and / or not consistence meta-data supplied. Similarly, in a large number of cruises were there significant problems / work with merging data in a consistent way.
A new data table was presented and distributed to the participants. The cruise list consists of 91 fully processed (1st level QC, marked in black) and 56 cruises where there still is some work to do (marked in red), for some cruises not much, but for others it might be significant amount of work to be done for the merging and 1st level QC. A CD with all at the moment available data (~91 cruises) was distributed to the participants. In addition to these "CARINA" cruises, the cruise list also consists of 10 recent, CarboOcean funded cruises.
We discussed the naming convention of the cruises, and nobody came up with a better naming convention than the one that Bob is using, which is (usually) a number followed by an acronym for the ship, and then year and month when the cruise started. *Bob stressed that we should always use this cruise number in subject line of all communication*.
Everybody was urged to go through the list and watch out for mistakes.

The data CD consists of several directories, one for each research vessel, and then subdirectories for each cruise. There one can find the data, the meta-data and what ever other documentation that is available (such as cruise reports). The files are all as comma separated csv-files. The number and order of the columns are not uniform, but the headers are uniform, and so are the units (always mol/kg). There are thus no empty columns in the data files, and the columns needs to be matched to the column header, and Bob urged us to use only read routines that does that (rather than column number). All the data have an associated WOCE flag.

Bob noted that there was frequently unclear whether "depth" in the submitted data really was depth, or just pressure that was labeled as such in error. Similarly, there were occasions when the unit was unclear (i.e. mol/kg or mol/L), or the reference temperature was unclear, or likely wrong. In the cases when it was relevant (pH and pCO_2), a column

for reference temperature was added. For most cruises, the original station numbers were retained, but on a few instances they were changed (i.e. subtraction of 1000022, or similar). It was agreed that Bob should add a column in the data table that states general region (i.e. AMS, NA, SO). The group meetings identified most of the cruises to the correct region.

During the 1st level QC, Bob looked for outliers; first property vs. pressure; then, property vs. property. If a data-point was out on both tests, they were flagged.

Bob advised on a draft to updated "Guide to Submitting CTD/Hydrographic/Tracer Data and Associated Documentation to the CLIVAR and Carbon Hydrographic Data Office", by Jim Swift. A suggestion for a short (i.e. ~ 2 pages) summary was raised, and suggested as an improvement to the manuscript.
Very often during the CARINA data collection, the meta-data were incomplete, wrong or not existing. *Bob urged us all to read the guidelines, bring them to sea, to follow them, and generally to do better in the future!*

5. 2nd level quality control

Rik Wanninkhof discussed the experience of doing the Second-Order-Quality Control of Inorganic Carbon data, particularly the cross-over (X-over) analysis of carbon parameters made in the Atlantic Ocean from 1990 to 1998 (ORNL/CDIAC-140).
According to Rik, "QC is a painful job", and the aim here is to make QC easier, more consistent and more objective. The process must therefore be automated, at least to some degree.
The goal is to create a new data product (2nd level QC), that can be presented next to the data base (only 1st level QC). To do this we will need to look at depth dependent trends and drifts in the data.

1.1 General Questions and Comments:

- How can the process be streamlined and automated?
- How do we determine limits of acceptability for offsets?
- Can / should these limits differ for different location? In data sparse regions is low quality data better than no data?
- How do we assure that our recommendations reach the responsible PIs to update their datasets, or don't we worry about this? That is, we'll create a new datasets
- Is this detail necessary, or can we do "brute force" regional assumptions?
- The methods do not lend themselves to assess drifts and erroneous trends in data.
- Noisy data ends up with greater tolerances than clean data.
- Should other relevant biogeochemical and physical parameters undergo the same rigorous checks? *Suggestion: Do this for all parameters used for the C_{anthro} calculation, i.e. include oxygen, nutrients, salinity, CFCs.*

Rik gave an example how erroneous silicate data in the Pacific could bias the results for C_{ant} when an MLR method is applied. The GLODAP nutrient data did not get thorough QC

Steps:
A. Individual cruises
While in theory the first-order QC by individual investigators should have dealt with all the individual cruises, experience has shown that this step has to be redone by the synthesis team prior to synthesis.

A1. Make a [subjective] assessment of quality of data (based on factors such as group that performed measurements (experience, prior results), available meta data, number of samples, sample handling instrumentation, results of CRM, and cruise duration).

A2. Do a first order check of pertinent parameters (contour plots, water fall plots) versus depth and/or versus density.

A3. If no TA is available, calculate it from TA = f(DIC, pH) or TA = f(DIC, pCO_2). Note, assure that you have the right temperature and scale.
The meeting participants agreed on the recommendation from Fiz Perez that there is no strong enough arguments to change the constants that has been mostly used so far, i.e. the constants by Mehrbach as reformulated by Dickson an Millero with the Dickson constants for the sulfate

A4. Omit all data with QC other than 2 or 6 from further analyses.

A5. Perform internal consistency calculations DIC = f(TA, pCO_2); DIC = f(TA, pH).

A6. Perform a MLR with other parameters of interest to check for outliers
Alk = f (T, S, Si, NO_3)
DIC = f (T, S, Si, NO_3, O_2)

A7. Visually scan for outliers of difference in measured and calculated values, and determine which of the parameters appears in error.
Note, depending on the dataset, the outliers checked are those 2 or 3 times sigma removed from the standard deviation of difference. While the questionable data point could be any of three to Adjust QC flags accordingly- note this now is a "new" dataset and should be treated as such.

A8. If step 6 flags a significant number of TA, or DIC values, redo 4.

A9. If 3 or 4 C-system parameters are available determine systematic offsets between calculated and measured parameters and compare with results of other cruises.

<u>B. Combine datasets</u>
This is the part commonly referred to as the 2nd order quality control

B1. Find cross-over points with station containing C-data (usually determined as stations within 1 degree (≈ 100-km) of each other).
This was discussed during the meeting, and it was agreed on that the distance between stations that can be regarded as an X-over has to be determined on a case by case basis, i.e. in the Southern Ocean where only few data exists longer distances can be tolerated. Also in "quiet" areas of the ocean longer distances can be tolerated, whereas special care has to be exercised in areas with topographic features.
The length scale for X-over analysis (as well as the maximum time between the two cruises) will also be influenced by parameter, i.e. for a parameter with few measurements (for instance, every second station for DIC) it might be justified to use larger distance.
In generally, it is better to discard an X-over if large variability is suspected at a certain location, rather than risk having a "faulty or bad" X-over influences the recommended offsets.

It was recognized that the X-overs should be done in a routine way, for consistency, but that it still requires being manual, so that the operator can visually determine the quality of data and the validity of the offset.

B2. Select depth where you expect no changes over the time period of comparison (> 1500 m). Discuss merits of checking versus depth and versus density
It was agrees that we will do X-over analysis on in depth space for salinity (obviously) and in density space for everything else (probably sigma-4). For our area the point was raised that we should avoid using data from the 100 meter closest to bottom, since there tends to be transient trends there.

B3. Perform crossover analysis by plotting DIC or TA versus sigma-4 (explain details)
This has been very subjective based on the "flat part" of the density/property plots: Rik advised to use a linear regression

B4. Assess differences and determine if differences are systematic for the entire cruise.
When is an offset an offset?
The group discussed limits, and come up with some general agreements:
4 umol/kg for DIC
6 umol/kg for alkalinity
2% for nuts and oxygen
0.01 (?) for salinity
0.005 for CFCs
Or in more general terms:
2 standard deviations of the weighted standard deviation of an X-over.

Offsets: *Multiplicative for nutrients, oxygen, pCO2, CFC*
Additative for DIC, Alkalinity, salinity, CFC pH,

B5. Do a regional MLR and determine if differences are consistent with cross-over conclusion if crossover shows an appreciable difference.

B6. Adjust values in new dataset.
Note- these methods will provide an assessment of systematic offsets and will work best on precise datasets. Datasets with drifts over time or trends with depth are more difficult to adjust. In general it is difficult to determine biases that are smaller than 3-4 umol/kg (for DIC and alkalinity).

6. Matlab routines for the X-over analysis.

In an attempt to streamline the X-over analysis, Toste presented matlab routines that can be used for everyone. The principle way the package works is:

- Identify stations / cruise that can be regarded as a X-over
- Plot data vs. depth / density
- Interpolate each station on the density or depth grid
- Average the profiles from each cruise, and calculate the standard deviation
- Calculate the offset and the standard errors / deviation of the offset
- Display the data and store the offsets and a measure of the certainty

It was decided by the participants that Toste should develop the routines a bit more, so that there is an easy to use package for the members of the group that do the X-over.

The step from X-over offsets to suggested cruise adjustments

Steven van Heaven discussed a method to mathematically determine the optimum suggested adjustments to the data based on a large number of offsets. Steven used the publication by Johnson et al. 2001 (*Journal of Atmospheric and Oceanic Technology*) as based for his discussion, and recommended all the participants to read this carefully crafted paper carefully. Steven also presented some matlab routines that will do the analysis.
The meeting agreed on that this might be a good way of doing an objective way of making the transfer between measured X-over offsets to make suggestions of cruise adjustments. Steven will develop a matlab routine for this, together with Toste and Alison. The group also recognized the advantage that cruises can be weighed differently. For instance can X-over done vs. already adjusted GLODAP data be weighed high, as can cruises where there is solid reason to believe that the data has very high standards (could apply to CLIVAR cruises)?

7. Isopycnal and MLR analysis

It is clear that for some regions, for instance the Nordic Seas, it is not practical to do X-over analysis, and thus some other method of 2nd level QC will have to be employed. We discussed the use of MLR over specific areas or / and specific isopycnal layers. The advantage of using isopycnal analysis is that water mass dependent bias will likely disappear and the MLR analysis is likely more robust. It was agreed on that Are will develop flexible matlab routines that allows us to, in a consistent manner, do MLR analysis.
The potential power of basin wide MLR was recognized, particularly for a comprehensive data set as CARINA. Box and whiskers plots were identified as a very useful way to identify cruises with data that are offset.

8. Consistency control of CFC data

John Bullister talked about the experience made during the synthesis efforts of the WOCE CFC-data. CFC data are difficult to do a 2nd level QC of mainly due to low concentrations in deep water (were there is possibly fewer temporal changes), and rapid transient signal. The main tools for CFC consistency control were as follows:

- CFCs vs. depth,
- CFC-11/CFC-12 vs. depth
- CFC-11/CFC-12 vs. CFC11
- Surface saturations (is normally close to 100%)
- Air Measurements (compare to known atmospheric concentrations)
- Crossovers (Johnson et al 2001):
  - 350 km;
  - interpolated to potential temperature surfaces
  - polynomial fit vs. distance to crossover

The results of these procedures resulted in feedback to the PIs, with suggestions for corrections. In all / most cases, the PIs were supportive of the suggested corrections, which were all made to the data, i.e. as a 1st level QC. This is slightly different from the other parameters, but is justified by the particular problems that are associated with 2nd level QC of CFC data.

9. Coordination with the Pacific synthesis effort.

The day started with a presentation by Masao Ishii, who presented some preliminary

results “Increasing trend of DIC in the western North Pacific since early 1990´s”. Masao showed a nice time series of significantly increasing DIC in the NW Pacific. It was concluded that in a time series like this, eddies and large scale variability (ENSO) must be taken into account.
Masao’s presentation introduced a presentation by Bob Key regarding the North Pacific effort. Bob reported briefly from the workshop held during June 2004, “Understanding North Pacific Carbon-cycle changes: A Data synthesis and modeling Workshop”. The workshop resulted in a special issue of JGR in 2006. Most progress was made on surface CO_2 because water column data were not readily available in accessible format.
Increasing trends in most of the Pacific was noted, with exception of the Western Subarctic Pacific. Most of these trends could be explained by physics, but in the west Pacific, biology seemed to be an important factor.

The Pacific data synthesis is under way, and similar to our effort, there are three working groups: North Pacific (Sabine, Murata, Ishii), Equatorial Pacific (Feely, Ishii), and South Pacific (Tilbrook), and a “data manager” (Key) that will compile the data as they come in (when the Atlantic work slows down). Our group agreed on close cooperation with the Pacific effort, particularly for the Southern Ocean group where substantial overlap exists.
The experience from the Pacific group that was highlighted to us was: Participation of modelers from the beginning was very helpful; Having a clear goal and deadline kept people moving forward (JGR special section).
It was agreed on that Bob Key will represent our group during the next meeting of the Pacific group.

10. Forum

An internet portal has been established in order for the participants to effectively communicate and relay their results. Carsten Schiernick and Benjamin Pfeil led a discussion on the content and practicalities of the “Forum”. The Forum can be found at http://carboocean-ip.clientsection.com/login, and is password protected. The Forum is an interactive site, where everybody can leave messages and post data.
It was agreed that:

- We should use the forum, and that everybody should get used to the medium.
- We shall post all our results from X-over analysis etc. in the forum, figures and text.
- We shall post tables on the Forum where we can fill out X-over results as they come in. In this way it is easy for everyone to see what is to do, and to do it. It was envisioned that each entry in the table has a link to figures and meta-data.
- We should list suggested offsets, particularly if any cruise or parameter is a serious offset that will influence also other calculations.
- We should post draft of papers relevant for our work on the forum.
- Deadlines and milestones should be posted.
- The Forum shall include a member-list with email addresses.

Within shortly, everyone will get a password to the site from Benjamin.

11. Reports from the break-out groups

a) ***Arctic Mediterranean Seas:***

Data still to come:

- 3 cruises from Leif.

- Some from Kumiko (Baffin Bay and Canadian Archipelago and East Greenland Current.
- some Japanese data

DIC and Alk – MLR and crossovers and specific Nordic Seas method (2003 DSR, by looking at pCO_2 at 5 vs. SST)

Who is doing what and how:

- Emil will define some basic water masses to be used instead of density definitions. For the Nordic Seas: Atlantic water, Arctic Water, Intermediate Water, Deep Water, Norwegian Coastal Water – and EGC. In Arctic: Polar Mixed Layer, Halocline Layer, Atlantic Layer, Deep Water.
- Carbon Parameters: Are will make a script in Matlab creating MLR with box plots with flexibility in terms of input properties.
- Alkalinity vs. Salinity profile comparison – should be linear and not offset, some cruises did not have CRMs.
- Discrete pCO_2 – from the Iceland group – Jon is responsible.
- Discrete pH – Richard Bellarby .
- Nutrients – Solveig Olafsdattir, Thorarinn A. Will have MLR results, as well as crossover.
- Oxygen - Eva Falck.
- ^{13}C – Are – MLR
- ^{18}O do we have any data? Truls and Are will handle it – Salinity/Alkalinity relationship.
- T&S – Alexander experienced in the Nordic Seas (and Kjell Arne) – lot of the data is bottle downcasts without much CTD data. Will look at the deepest data and apply an offset to the whole profile if necessary. Alexander should have good input for the other variables as well.
- CFCs – Anders Olsson and Emil Jeansson – crossovers and repeat transect comparison, maybe MLRs just to see what it can give us.
- DOC – have one cruise, may be some more in Arctic – Yngve B.

Overall Plan/ Central Information: Are will create a table, which describes the recommended offsets – each offset will have a name + minimum a figure and explanation of from where the offset is derived

Schedule: plan a meeting in late August 2007, but more likely in September in Bergen.

Generate: mat and odv files (Benjamin will make ODV files). Matlab data will just be individual vectors for each property.

Accuracy and precision: Accuracy will be dealt with offsets, precision +/- 5 yes, +/-10 no, look at deep water profile scatter plots.

Papers:

- Emil, Sara and Toste; Arctic C_{ant} method comparison, Are in Nordic Seas – So method comes from ongoing work. How much is there and what is its spatial distribution will be based the method decided upon.
- How does C_{ant} enter: advection vs. atmosphere, how is transferred downward and how much transferred to adjacent basins. Volume flux budget as done by Melissa Chierici using model data.

- What is the rate of change in everything – how is this related to circulation and climate change.
- What are the associated changes in saturation state of carbonate minerals (Arctic MLR)?
- What are the future measurements we need to answer the above questions?
- Large permafrost store of organic carbon source should it melt.
- Synthesis papers on nutrient papers alone, but also carbon parameters. (Cant total concentrations and saturation state, total changes in these over the last 20 years using MLR approach, reconstruction approach, and observations, transport of the aforementioned, pathways & changes in Arctic and Nordic Seas circulation based on CFC's and SF6 (as well as age estimation & TTDs)

Working group should operate on the basin scale with the synthesized data.
Discussed who would be willing to lead the writing on these various topics

b) North Atlantic:

Discussion on participants within the group, and who is likely to do the X-over analysis. Responsibility for various parameters was assigned, and will be passed on to the persons involved. Identified cruises from Bob's data list that are within the NA domain.

c) Southern Ocean:

The working group will divide the work into specific regions rather than by parameter. A close cooperation with the South Pacific Working group is foreseen.

12. Development of New Coulometer for High-Precision DIC analysis

Masao Ishii gave us a short overview of the Japanese efforts to produce a new Coulometer. It was recognized by the group that such an effort is very welcome and highly needed to replace an ageing stock of available coulometers.
The new instruments are equipped with: Dual-beam photometric detection; Accurate electric current supply for titration by the temperature-controlled shunt resistor; Long-lived 610nm LED; Personal computer control *via* USB connection.
Efforts in progress: Downsizing and separation of coulometer into a cell compartment and an electric compartment using optical fibers that allows flexible layout of a DIC analyzing system; Development of a small high-performance spectrophotometer with optical fiber connection for spectrophotometric TA and pH analyses.
A limited number of units (~6 per year) can be provided after April 2008 as scientific instruments (as opposed of commercial instruments).

Questions raised included:
- Price?
- Can a changeable cell-design be built in?
- Can the cell design be improved?

It was recognized that once this units is available, there is likely to be a high instantaneous demand (possibly 15-20 units). It was recommended that the development takes this high demand into account, and try to accommodate this.

13. Action items and deadlines.

The next CarboOcean meeting will be held in Bremen in December 2007. It was decided

to precede that meeting with a data meeting, preferable at the Delmenhorst Science Center, December 1-2 (the weekend before the CarboOcean meeting).
This meeting to be held at, and proposed to, the Hanse Wissenschafts-Kolleg in Delmenhorst, by Mario and Toste.

Specifics:

- Tables of offsets in Forum with links to plots and meta-data.
- Do the X-over on depth for salinity and on density (sigma-4) for everything else.
- Keep good track of your work and be careful with writing readme files.
- Use bottle salinity if available, if not use CTD salinity.
- Make sure that standard deviation of the offset is noted in the table.
- For new matlab routines; make sure that they are flexible and well documented.
- Naming convention for cruises and X-overs. This got to be CONSISTENT.
- We will not restrict the 2nd level QC to CARINA data. We will also use other data sets such as GLODAP and other recent non-CARINA data (e.g. CLIVAR) for our analysis. Some of these data should be weighted high since they have already gone through a 2nd level QC.

Action items:

- Matlab routines; Toste will develop the X-over routine (together with Steven, Johnson method). Deadline: April 15th.
- Are will develop matlab routines for MLR. Deadline: May 15th.
- Denis Pierrot will port the CO2sys program of Lewis and Wallace in matlab. Deadline: May 15th.
- Each group to decide on the best method for there region.
- Suggestions for table format to pass around in the working groups.
- Bob shall provide merged data files for the three areas, three data files per region (GLODAP; CARINA; New data not in CARINA, such as CLIVAR etc.). These files will be easier to handle in the intercomparison.
- Make the tables with links to plots and readme files for the Forum.
- Bob sends the ocean interpolation routines to Toste.
- Bob will check our calculations that we put on the forum, and do an independent check.
- Benjamin will create a file-tree for the forum.
- Benjamin to set up group mail servers.
- Mario and Toste will organize the next data meeting (Delmenhorst) in early December.
- The working group leaders will design and post X-over tables in Forum.
- CarboOcean finishes by the end of 2009
- There will be no more cruises by the end of 2008
- **The CARINA data base with suggested adjustments are due by the end of 2007**

We agreed on that we will have all 2nd level QC done for the CARINA data base in time for the meeting in December. At this meeting we will come up with a suggestion of adjustments.

Work plan:

- The merged data files will be distributed to the working groups.
- The matlab routines will be distributed to the working groups
- Tables of X-overs will be posted on the Forum

- The group members will use the merged data files and matlab routines do perform the analysis and note the offset and standard error of the mean.
- Figures and meta-data associated with these calculations to be put on the Forum (possibly with links from the tables).
- Offsets determined from other forms of 2nd level QC will also be posted in the table in the Forum.
- The offsets will be treated and suggestions for adjustments will be produced by the group members.
- The suggested offsets will be presented at the meeting in Delmenhorst, and a group consensus will be given. This we can present at the CarboOcean meeting in December, and then send out to PIs for comments.

Toste Tanhua, Kiel, April 5 2007

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Group photo: Here are the participants of the CarboOcean Atlantic Ocean Carbon Synthesis Meeting in Kiel, March 21-23, 2007. After two days of miserable weather, it cleared up on Friday, and the group-photo was taken outside IFM-GEOMAR (where the meeting was held), in front of the seal-basins (where the seals lives).

Participants from left: Masao Ishii, Are Olsen, Marta Alvarez, Mario Hoppema, Rik Wanninkhof, Doug Wallace, John Bullister, Sara Jutterström, Toste Tanhua (front line), Reiner Steinfeldt, Alison McDonald, Steven van Heuven, Fiz Perez (front line), Aida Rios, Bob Key, Akihiko Murata, Claire lo Monaco, Christoph Kihm, Marcos Vazquez, Pete Brown. Missing on the photo are: Benjamin Pfeil and Emil Jeanson.