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Earth System Science Data Discussions

Interactive comment on "Assessing the internal consistency of the CARINA database in the Indian sector of the Southern Ocean" *by* C. Lo Monaco et al.

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First of all, we would like to thank Murata-san for taking time to review the manuscript.

The reviewer points out that it is surprising that only the data from the BEAGLE Indian Ocean cruise (49NZ20031209) shows a bias in alkalinity. We agree. The BEAGLE expedition was run as a single expedition with multiple legs. This scenario generally results in the most consistent data. We too were surprised to find the offset in the Indian Ocean while the Pacific and Atlantic results are within the expected uncertainty of other high quality data.

Based on the merged dataset used for the Indian Ocean cross-check analysis, we

detected a systematic offset in alkalinity between BEAGLE and WOCE data of about 10 μmoll/kg (Figures 1 and 2). As mentioned in your comment, this result agrees with your own conclusion from comparing similar cruise data. When the original comparison was done, WOCE was the logical metric (I3 line). We agree that this was only sufficient to say that there is a difference and that the difference is of order 10 μmol/kg. In CARINA, there is no new data to compare to BEAGLE, but there are new data to compare to WOCE. The decision to correct BEAGLE data rather than WOCE is based on these new WOCE-CARINA crossovers that do not show any systematic offset in alkalinity.

Urged on by your comment we present additional comparisons against other WOCE lines and against newer CLIVAR data (see below). Not surprisingly there is some variance in the offset for the different comparisons, but the trend is the same for every case and therefore we still defend our original conclusion and now with substantially more evidence.

Cross-check of BEAGLE alkalinity data against WOCE and CLIVAR data by R. Key and C. Sabine

- Section difference plot comparing WOCE and BEAGLE sections (Figure 2) This comparison better quantifies (8.3+/-1.5 vs 5-10 in the BEAGLE cruise report) yet totally supports the original Japanese conclusion that the two were statistically different. If we had nothing else to go on, I would conclude that it was impossible to determine which set of values was biased.

- Comparison to the CLIVAR I9N data from 2007 (Figures 3 and 6) The statistical significance of this comparison is not nearly as high as the section comparison (Figure 2) due to the limited amount of data and the fact that the I9N data aren't at exactly the same latitude. Regardless, it totally supports the conclusion that the BEAGLE data are low by about 8umol/kg. The difference is systematic within the measurement precision. Alkalinity from both U.S. cruises (WOCE I3 and CLIVAR I9N) were analyzed by Frank

Millero. This implies that the two U.S. data sets are not as independent as they would have been with different PIs. On the other hand, Frank consistently produces very high quality alkalinity measurements.

- Comparison to the WOCE I5WI4 data (Figure 4) Here, Doug Wallace was responsible for the alkalinity measurements, so this result is independent from the Millero data comparison. Again, the BEAGLE data are low, but here I'd estimate the difference to be a bit less ($\sim$5umol/kg).

- Comparison to the WOCE I9N data (Figures 5 and 6) Here the difference looks more like 10umol/kg. Chris Sabine was responsible for the WOCE I9N data, so again we have an independent comparison.

All of the WOCE and U.S. CLIVAR data were calibrated to Dickson CRM, whereas a locally produced CRM (from JAMSTEC and KANSO) was used during the BEAGLE cruise (note: Dickson CRM were used occasionally on BEAGLE as a second check). According to the BEAGLE cruise report, they experienced some electrode drift. They attempted to adjust for this drift.

Conclusions:

1. Clearly, there is a statistically significant difference between the Indian Ocean BEAGLE alkalinity data and that produced by various U.S. labs. On average the BEAGLE alkalinity data appear to be low by about 8umol/kg. The offset in the west may be slightly less than that in the east but the difference is too small to suggest a variable adjustment.

2. The fact that the BEAGLE data are low relative to measurements both before (WOCE) and after (I9N2007) implies that the difference is unlikely to be real (due to time variability). That is, for the deep waters the steady state assumption appears to be valid in this case.

3. All of the data were referenced to CRM, but from different sources.

4. The odds are that either: (a) the mentioned drift was not successfully compensated or (b) at least one batch of the Japanese CRMs were incorrect/biased for some unknown reason. Other conclusions are possible, however, they would all require a very special set of unusual circumstances/coincidences.

Taken together, we believe that a quite strong argument exists for adjusting the BEAGLE alkalinity data upward by $\sim$8umol/kg. We still don't have proof, but we do have substantial evidence.

Figure Captions:

Figure 1: Cross-over analysis for alkalinity data comparing BEAGLE (49NZ20031209, blue) and WOCE-IR4 (317519950922, red).

Figure 2: Difference plot for alkalinity (μmol/kg) between BEAGLE (49NZ20031209) and WOCE data (lines I3/I4).

Figure 3: Cross-over analysis for alkalinity data comparing BEAGLE (black) and CLIVAR I9N (red).

Figure 4: Cross-over analysis for alkalinity data comparing BEAGLE (black) and WOCE I5W/I4 (red).

Figure 5: Cross-over analysis for alkalinity data comparing BEAGLE (black) and WOCE I9N (red).

Figure 6: Cross-over analysis for alkalinity data comparing BEAGLE (black), CLIVAR I9N (red), WOCE I9N (green) and WOCE I3 (yellow).

Interactive comment on Earth Syst. Sci. Data Discuss., 2, 367, 2009.

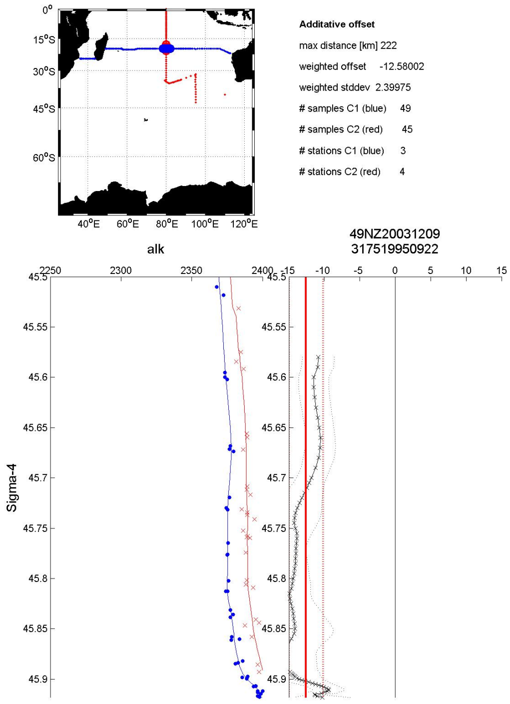
Additative offset
max distance [km] 222
weighted offset -12.58002
weighted stddev 2.39975
samples C1 (blue) 49
samples C2 (red) 45
stations C1 (blue) 3
stations C2 (red) 4
49NZ20031209
317519950922
alk
Sigma-4

Fig. 1.

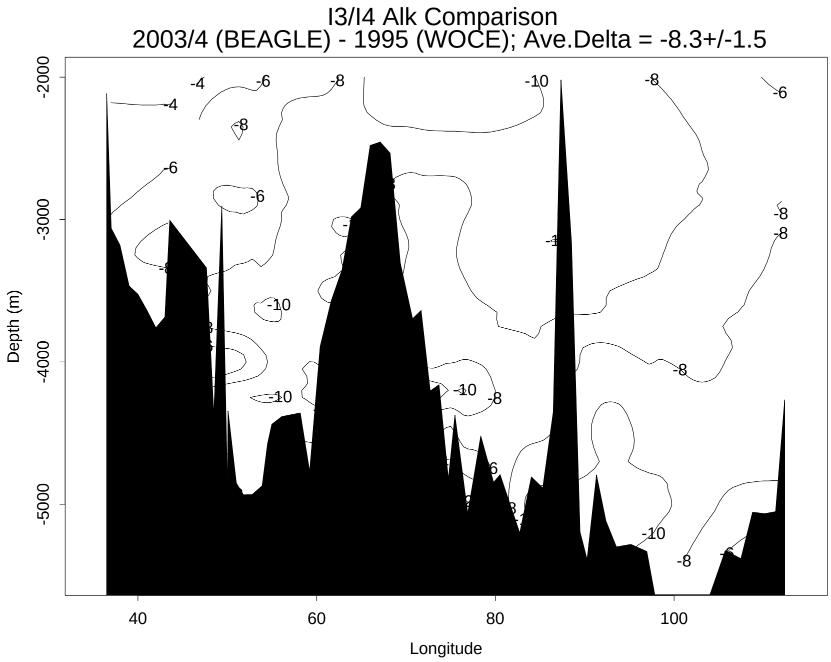
I3/I4 Alk Comparison
2003/4 (BEAGLE) - 1995 (WOCE); Ave.Delta = -8.3+/-1.5
Depth (m)
Longitude

Fig. 2.

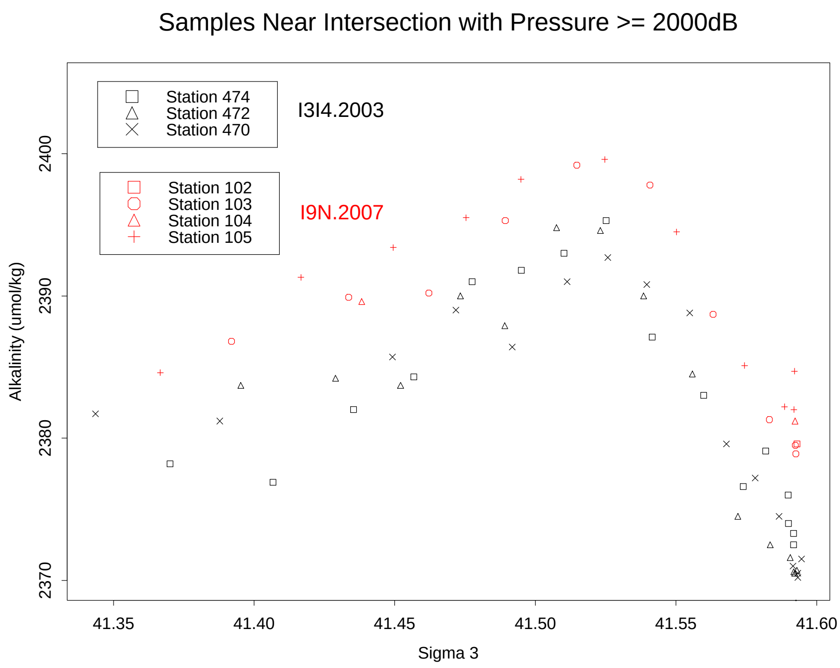
Samples Near Intersection with Pressure >= 2000dB
Station 474
Station 472
Station 470
I3I4.2003
Station 102
Station 103
Station 104
Station 105
I9N.2007
Alkalinity (umol/kg)
2370
2380
2390
2400
41.35
41.40
41.45
41.50
41.55
41.60
Sigma 3

Fig. 3.

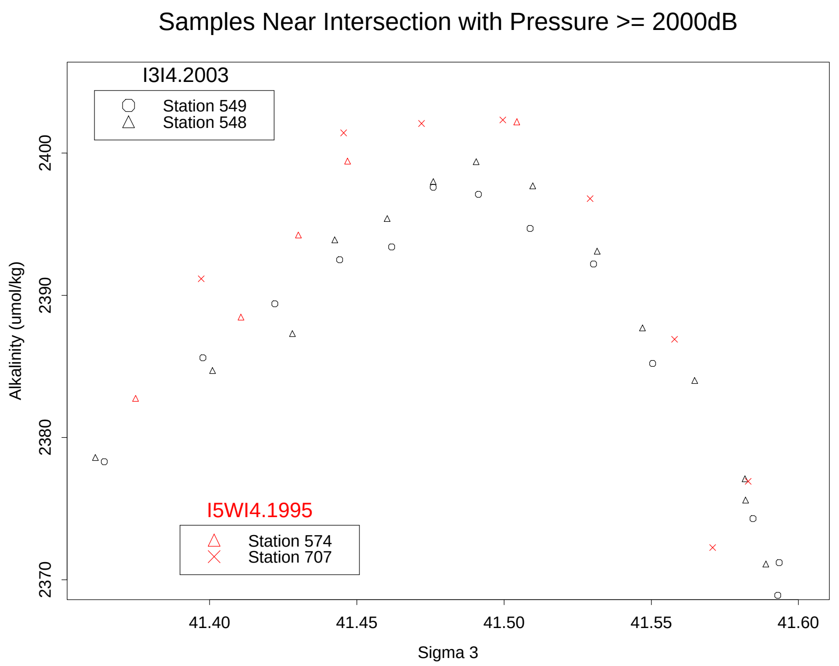
Samples Near Intersection with Pressure >= 2000dB
I3I4.2003
Station 549
Station 548
I5WI4.1995
Station 574
Station 707
Alkalinity (umol/kg)
2370
2380
2390
2400
41.40
41.45
41.50
41.55
41.60
Sigma 3

Fig. 4.

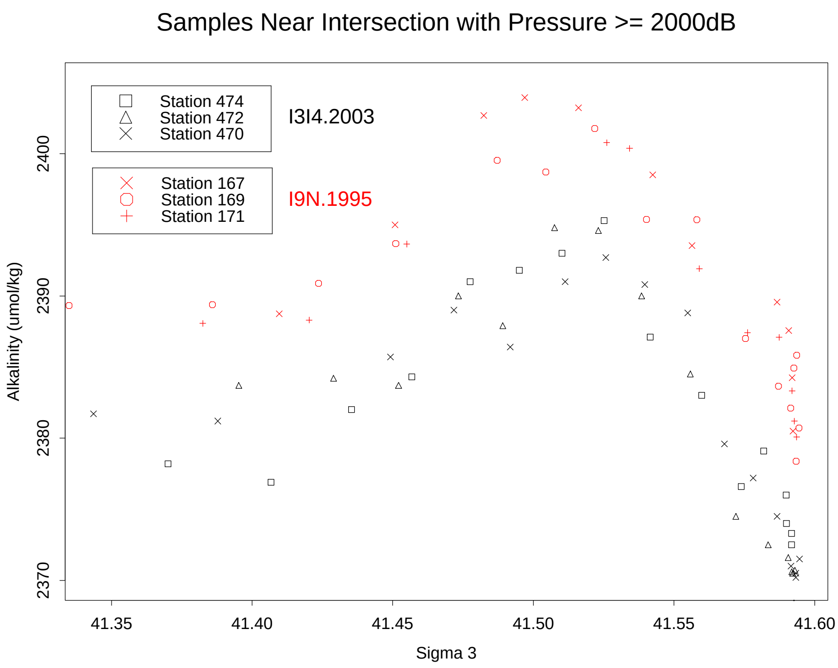
Samples Near Intersection with Pressure >= 2000dB
Station 474
Station 472
Station 470
I3I4.2003
Station 167
Station 169
Station 171
I9N.1995
Alkalinity (umol/kg)
Sigma 3

Fig. 5.

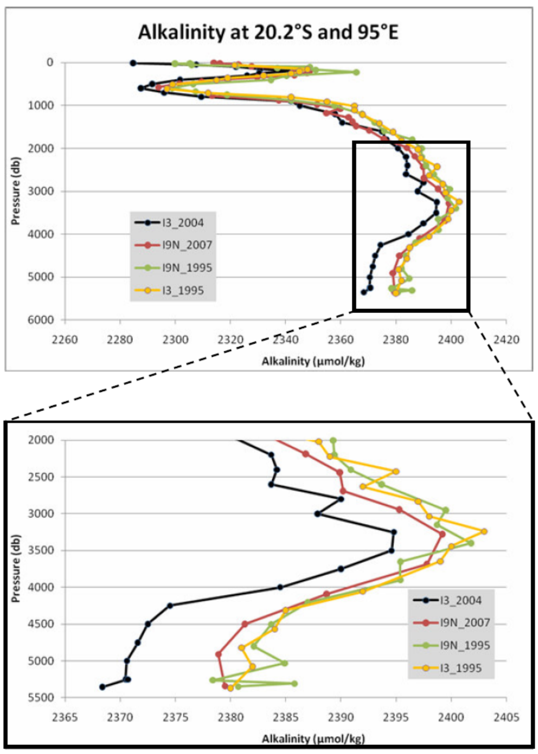
Alkalinity at 20.2°S and 95°E
Pressure (db)
I3_2004
I9N_2007
I9N_1995
I3_1995
Alkalinity (µmol/kg)

Fig. 6.