

Interactive comment on “The Irminger Sea and the Iceland Sea time series measurements of sea water carbon and nutrient chemistry 1983–2006” by J. Olafsson et al.

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Response to referee#1 comments

After general and positive comments on the manuscript, referee#1 has several comments most of which refer to the TCO₂ QC section. It is clear to us that in the revised manuscript this section needs to be clarified taking notes of the comments and Figure 4 will be revised. Here we will attend to each of the reviewer's remarks:

- C1. DRM is a typographic error of CRM (Certified Reference Material).
- C2. There were no samples and no CRMs analysed in 1999 and 2000. The reason be-

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ing instrumental overhaul and repairs. Samples collected in this period were analysed in 2001 and 2002. The samples were all spiked with HgCl_2 which has been found to be an effective preservation method. The samples were furthermore stored refrigerated at a stable temperature (4°C) and in darkness.

C3. The loop volume correction, multiplier 1.0029, was applied to all results analysed at MRI in the period 1991 to 1998, including those from the IRM and IS stations.

C4.-C6. The samples which we collected 1999-2000 and in following years, and which we analysed at MRI, were compared with CRMs analysed concurrently and adjustments made on the basis of the comparison results. Thus all the TCO_2 results have been adjusted by comparison with CRMs and there is no reason to suspect periods of uncorrected data in the time series.

C7. When judging the precision from the appearance of points in Fig. 4 it must be realised that there are about 380 points in the figure and that those outside the standard deviation limits have relatively little weight. We want to estimate the precision and accuracy for the whole time series. Thus the basis for the estimate is the results from the CRM, i.e. the differences between certified and measured concentrations. This indicates a precision of $\pm 2 \mu\text{mol C kg}^{-1}$. The accuracy is, of course, tied to the use of CRMs. Our estimate of $\pm 1 \mu\text{mol C kg}^{-1}$ is perhaps optimistic and a critical assessment would be $\pm 2 \mu\text{mol C kg}^{-1}$.

C8. The reviewer's comments that the loop volume error should be corrected with a proportional factor. We express the magnitude of this error as $-4.7 \pm 2.0 \mu\text{mol C kg}^{-1}$ but we corrected for it with the multiplier: 1.0029. The concentrations in the CRMs we have used have ranged from $1927 \mu\text{mol C kg}^{-1}$ to $2112 \mu\text{mol C kg}^{-1}$. This is a relatively small range, $\sim 10\%$, and we consider little gained in expressing concentration differences as "relative" rather than "absolute" as the reviewer suggests. The CRM results after 2000, which indicate a bias of $+5.3 \pm 2.0 \mu\text{mol C kg}^{-1}$ are, we believe, not due to a loop volume error but rather related to instrumental settings. This bias is not

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clearly related to the CRM concentration and it may well be constant.

Reviewer#1 has 4 minor comments which we will take note of in the revision of the manuscript.

M1. When we have not been able to reach the time series location but had observations from the region, a nearby station, these have been incorporated into the time series. The nearby stations are generally within 70 km from the time series location except in 1983-1984 when the Iceland Sea sampling was 250 km to the west of the fixed location.

M2. The colorimetric methods for the analysis of nutrients in sea water have linear concentration-absorbance relationships. However, when using continuous flow automated adaptations of these methods the tendency for dilution between sample and wash may lead to a weaker colour than in manual methods on discrete samples. This applies in particular to high concentrations. Hence we use polynomial regressions to fit response to concentration.

M3. Reviewer#1 correctly notes that the concentrations in the nutrient reference materials (RMs) have been variable over the years. The RM concentrations have sometimes been well above the range observed at the time series locations. We therefore have chosen to compare the mean difference between our observed RM and the assigned RM concentrations with the high level of nutrient concentrations found on the time series stations. This eliminates the effect of variable RM concentrations.

M4. The description of the TCO₂ data as “appeared reasonable” is taken directly from the reference cited. In the revised manuscript the words will be within quotation marks.

Response to referee#2 comments

Referee#2 has commented positively on the value of the time series measurements. This is gratefully appreciated. Then he/she has specific comments which we respond to:

C1. The issue of sampling frequency to resolve seasonal processes is important. From other studies (unpublished) in the regions of the time series we know that quarterly sampling is insufficient to adequately describe annual biochemical processes. It has, however, been estimated, with respect to hydrographic variability in sub-arctic waters of the N-Atlantic, that 4 observations/year is a minimum to record decadal variability (Hátún et al., 2005). We agree with referee#2 that our quarterly observations can serve good purpose in interannual variability analysis. We will address this issue in the revised manuscript.

C2. There is some scope for different interpretations of the results we present on TCO₂ in Certified Reference Material. As explained in our response to referee#1 comments, we will revise this presentation.

3. Two typographic mistakes are pointed out which will be corrected.

Reference

Hátún, H., Sandø, A., Drange, H., and Bentsen, M.: Seasonal to decadal temperature variations in the Faroe–Shetland inflow waters, in: *The Nordic Seas: An integrated perspective*, edited by: Drange, H., Dokken, T., Furevik, T., Gerdes, R., and Berger, W., American Geophysical Union, Washington, DC, 239-250, 2005.

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