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Earth System Science Data Discussions

Interactive comment on "Overview of the Nordic Seas CARINA data and salinity measurements" *by* A. Olsen et al.

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Reply to referee 1 comments on "Overview of the Nordic Seas CARINA data. . ..." by A. Olsen et al.

I would first of all like to thank the reviewer for taking time to carefully read the manuscript and for providing me with comments. This furnishes me with an excellent opportunity to improve the manuscript.

In the following I will go through the reviewer comments one – by –one. The comments are given in italics and our response in regular font. Since some of the comments of reviewer 1 and 2 raised the same issues, I have added numbers to each comment to enable cross-references

1.1 *The article describes processing of the salinity observations in order to construct consistent dataset without systematic biases for the Nordic Seas (NS) region. First level QC (outliers and obvious errors) will be described in another article (Key et al., 2009, in preparation). Secondary QC on salinity was applied for 35 cruises from the total 188 non-publicly available cruises collected in the CARINA database. To identify cruise-to-cruise salinity biases a weighed least squares (WLSQ) model was selected recommended in Johnson et al., 2001. Since there is no complete description of the method in the article (details in Tanhua et al., 2009 submitted) it may be useful to provide some additional information about the secondary QC. For instance about a criterion was chosen for the crossovers definition and an explanation why it is optimal. Obviously,it should be linked to water mass properties of different origin and their geostatistical characteristics.*

The article that describes the method has now been published in ESSD (Tanhua et al. 2009) and the full details of the crossover method appear there. But, we also understand the value of including a description of the approach in each paper, and will include one in section 4.1 in the revised manuscript.

1.2 *There are some deviations from methodology described in Johnson et al., 2001. Page 9, line 21-22: 'the analysis in most regions evaluates cruise-to-cruise differences in density space (Johnson et al., 2001), depth was used as the ordinate in the Nordic Seas due to the small density gradients in this region.' Page 9, line 23-24: ': : :only samples deeper than 1900m were compared to avoid effects of ventilation' Actually, potential temperature surfaces were used in Johnson et al., 2001. And it is not clear why density gradients in the Nordic Seas are smaller than in the WOCE dataset. It may be because the only deep samples were used. In Johnson et al., 2001 full depth profiles were incorporated into the analysis. It is need to specify that such simplification does not effects the final conclusions about salinity quality in the upper layers.*

The reviewer correctly points out that Johnson et al. (2001) use potential temperature in their analyses, not density as stated in the manuscript. We will correct this in our

ESSDD

2, C46–C50, 2009

revision. We could not use potential temperature in the Nordic Seas as for instance sub-zero temperatures are found both at the surface and in the deep water column in the Nordic Seas, therefore depth was used. This will be clarified in our revision

As the reviewer points out, our analysis compared only deep data, and not the full depth profiles. We do not believe that this affect the conclusions about salinity in the upper layers since the potential causes for systematic salinity offsets, for example batch differences among standard sea water, would induce a constant offset. This is also exactly why Johnson et al. (2001) applies one offset to salinity data from all depths for each cruise. We will explicitly state this in our revision. Using data from higher up in the water column, where hydrographic variability is larger, would have greatly complicated the interpretation of the crossover and inversion results, in particular for total inorganic carbon, which is the main parameter for CARINA, because ventilation time and not only hydrography will introduce variations.

1.3 *The WLSQ method was selected as optimal for WOCE (high quality standard!) repeated standard sections with rather uniform crossovers spatial distributions between cruise legs. The CARINA data collection represents more scattered data with one exception – repeated section along 75o in the Greenland Sea. It is questionable how temporal variations of the deep convection activity in the central Greenland Sea can be expanded to the whole NS and North Atlantic. Observations in the Atlantic domain of the Nordic Seas do not show salinity increase in the intermediate and deep layers during the 1990s, most probably due to reduction in light to dense water transformation (see Isachsen et al., 2007 for mechanism). It was mentioned also that ventilation was not penetrated deeper than 1500 m, so why 1900 m was selected as limiting depth? It potentially limits a number of samples for crossovers. Reference: Isachsen P. E., C. Mauritzen, H. Svendsen (2007). Dense water formation in the Nordic Seas diagnosed from sea surface buoyancy fluxes. Deep-Sea Research I 54, 22–41.*

Regarding the trends in the Greenland Sea, compared to the rest of the Nordic Seas and North Atlantic: Without doubt, our statement regarding the deep water trends,

ESSDD

2, C46–C50, 2009

i.e. the increasing salinity, describes a Greenland Sea phenomenon. It has not been our intention to "expand" this to other regions of the Nordic Seas. Most of the crossover points used in our inversion analyses were located in the Greenland Sea, (the crossover results in themselves can be accessed at the " Secondary QC and final adjustments for the CARINA cruises" link at the CARINA home page at CDIAC). The trends in this region will therefore dominate the inversion results, but they should in now way be interpreted as a generic Nordic Seas phenomenon. We will make this clearer in our revised version.

Reg. ventilation depth. Actually, ventilation penetrated down to 1600 m (Ronski and Budeus, 2005) and not 1500 m as stated in the submitted manuscript. This will be corrected. We chose 1900 m to be on the safe side, this will also be stated.

1.4 *Page 11, line 15-17: 'There is an overall trend towards higher salinity values, i.e. increasingly negative corrections. This is consistent with the aforementioned increasing fraction of deep waters from the Arctic Ocean in this region (Blindheim and Rey, 2004) and should not be corrected for.' As was mention AODW (EBDW,CBDW) spreading is not only the process that affects properties of the deep water masses in the Nordic Seas. Therefore it is look strange that all salinity corrections are negative (Fig.4) particularly for cruises where the most stations located outside the central Greenland Sea (Fig.3).*

I do not understand this comment. By looking at the numbers used to create Fig. 4 I found 17 negative and 13 positive salinity corrections in the uncorrected data ("original data" in Fig. 4) and 12 negative and 17 positive in the corrected data ("Consistency check" in Fig. 4).

1.5 *Three cruises (58JH19920712, 34AR19970805, 58JH19940723) which according to the WLSQ analysis potentially require adjustment (Fig.4) were marked as 'not considered'. Main reason is that salinity samples located in overflow area with limited number of crossovers and different variability. Obviously the number of crossovers*

ESSDD
2, C46–C50, 2009

will be low due to samples selection criterion (>1900 m) and additional information is required. It can be recommended to involve data from much more comprehensive datasets (ICES, NODC World Ocean Databases) to check consistency of the regional subsets of the CARINA database.

This is a good suggestion. Unfortunately, time constraints does now allow for such an analysis right now.

1.6 *One problem potentially arises when merging CARINA data with existing databases. In common oceanographic databases station time is a necessary field while in CARINA collection time is missed. Disadvantage is that duplicate control especially in the case of multi-days stations is very complicated.*

I agree that time should preferably be included. However many of the data sets did not include time and even in those that did, these may be start cast time, bottom time, end cast time or individual bottle trip times. I.e assigning a unique and true time stamp was impossible for many of the data, and it was left out.

1.7 *Typing Errors Abstract, line 20. It should be 0.005 instead 0.05. Page 12, line 18. EXPOCODE 34AK19970414 does not exist, it should be 34AR19970805*

Both of these will be fixed in the revision.

Interactive comment on Earth Syst. Sci. Data Discuss., 2, 1, 2009.