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Interactive comment on "Enhancement of the North Atlantic CO_2 sink by Arctic Waters" *by* Jon Olafsson et al.

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Author response to Ref#2 comments We thank the referee for insightful comments on the oceanic regions studied and constructive suggestions for improvement.

General comments We respond to four issues raised by Ref#2 under General comments. 1 The referee objects to the use of the term Irminger Sea in connection with results from the time series station IRM. The oceanographic conditions in the Irminger Sea change when examined from south to north or from east to west and they also

change with time (Våge et al., 2011;Våge et al., 2009). We present data from a 5 station section 1993-1994 which includes IRM and from the IRM time series. In the Methods section. Line 134, we refer to this region as the "northern Irminger Sea" and consider it correct. The use of the IRM time series data is now clarified in the Methods section.

2 The referee points at CO2 sink/source temporal variability in the Irminger Sea. We add a sentence on the long term variability to the presentation of Fig. 6b.

3 The referee is expresses concern with the discussion on total alkalinity. Both Ref#1 and Ref#2 call for information on TCO2 and alkalinity to support the analysis. The discrete sea water sample pCO2 data we present generally include TCO2 results. ALK may thus be calculated. The call for information on TCO2 and ALK brings a complex temporal and biogeochemical variability in the Polar Water into focus. We intend to present another paper on that subject which we find too extensive to be added to the present paper. However, the referee suggestions may perhaps be met by adding summary information in figures of a kind similar to Fig. 6a and expand accordingly the Results and Discussion sections? That may still leave detailed observation materials for another presentation.

4 The comments on Figure 7 are most relevant. The figure is intended as a basis for a discussion. It illustrates merely the effect of excess alkalinity on Atlantic Water, S:35 and t: 5°C, reaching the Nordic Seas. The figure gives no indication of how the excess is generated or how it acts in the transformation of Atlantic Water to Polar Water. We add elaborations on this issue in the Discussion.

Specific comments Line 86 Very relevant comment. A sentence and reference is added (Hátún et al., 2005) which includes IRM station observations.

Line 92 The words "a portion of" added.

Line 189 We use 30 day running means of U2 and interpolated atmospheric pCO2

numbers for calculating fluxes as outlined in the Wanninkhof papers referred to.

Line 193 The CO2-ICE data from the Vestmann Islands only extend back to 1992. Both CO2 ICE and Mauna Loa CO2 data are at 1 atm pressure. The CO2_ICE and Mauna Loa records were processed in an identical fashion. Periods where CO2-ICE is missing are added to Methods section.

Figure 1 We agree with the reviewer. Further details would not make the figure more informative.

References Hátún, H., Sandø, A. B., Drange, H., Hansen, B., and Valdimarsson, H.: Influence of the Atlantic Subpolar Gyre on the Thermohaline Circulation, Science, 309, 1841-1844, 2005.

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Våge, K., Pickart, R. S., Sarafanov, A., Knutsen, Ø., Mercier, H., Lherminier, P., van Aken, H. M., Meincke, J., Quadfasel, D., and Bacon, S.: The Irminger Gyre: Circulation, convection, and interannual variability, Deep Sea Research Part I: Oceanographic Research Papers, 58, 590-614, https://doi.org/10.1016/j.dsr.2011.03.001, 2011.

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