

Interactive comment on “Increasing transports of volume, heat, and salt towards the Arctic in the Faroe Current 1993–2013” by B. Hansen et al.

Anonymous Referee #3

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Hansen et al. summarize the available data along Section N in the Faroe Current and develop a method for merging in situ and satellite observations to produce estimates for time series for volume, heat, and salt fluxes of the Atlantic Water component in the Faroe Current. They note a general increase in all of the fluxes of Atlantic Water. This work is relevant, proposes a novel method, and reaches a substantial conclusion.

My overarching concern about this manuscript mirrors the other reviewers', namely, that the majority of the information about the method used here is in a separate document (Hansen et al., 2015) and it is unclear whether or not the content of that other document is peer-reviewed. Most of my major concerns outline what I believe to be essential information in the technical report that is missing from the manuscript. Concluding my summary, I would like to emphasise that I think a lot of thought has been

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put into a difficult question, the method developed by Hansen et al. is a valid approach, and it is worthy of publication. However, some parts of this manuscript need more detailed documentation.

Major Concerns:

1) Section 2.2: Although in the technical report, details about the extrapolation of the ADCP data to the surface should be included in the manuscript because this extrapolation is a significant contribution to the overall error estimate (Hansen et al., 2015, page 48) and extrapolations, in general, must be treated very carefully. Furthermore, when reading the technical report, it does not describe the criteria for how “we extrapolated $\alpha(z)$ by eye” (Hansen et al., 2015, page 9). I think that Figure 2 in this manuscript, which is not present in the technical report, is a useful starting point for explaining the extrapolation. To make for a consistent explanation, Figure 2.2.2 from the technical report should also be included in this manuscript.

2) Section 2.3: I believe that Fig. 3 is one of the most insightful and pivotal figures in the method used here. However, I think the version in the technical report (Hansen et al., 2015, Fig. 2.4.4) is clearer because the extra black lines show precisely how the ADCP point measurements were interpolated onto the large-scale altimeter grid and a contribution of this interpolation to the overall error estimate. This interpolation should be outlined in the manuscript because it is, in my opinion, unclear, in the manuscript, precisely how the blue lines and black squares of Fig. 3 are used to construct the red line. Furthermore, at the end of Section 2.3, no mention of Fig. 3 is made even though Fig. 3 is, in my opinion, essentially the key result of Section 2.3. After explaining the interpolation process more fully and citing Fig. 3, I don't see the need to cite Table 2.4.4 in the technical report here as it contains essentially the same information.

3) Section 2.4: I believe that the relative profile equation (Eq. 5.1.2, Hansen et al., 2015) should be included and defined in the manuscript. It won't add much length since it's a simple equation but it will be a huge help for readability. Furthermore, Section

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3.1, line 12 says the relative profiles are “defined in Sect 2.4” but they are actually not defined since Eq. 2 shows the use of the relative profile but not the definition.

4) Section 3.1, line 21: I am really confused by the reference to Table 2.4.1 (Hansen et al., 2015) here. At the end of Section 2.3, the authors state that U_{k^0} values come from Table 2.4.4 (Hansen et al., 2015). Please explain the difference between these two tables or confirm that it is only one and not the other that is used. If Table 2.4.1 in the technical report is cited, then some explanation must be provided in the manuscript for how the altimeter data is interpolated to the positions of the ADCP's because an interpolation is implied in Table 2.4.1 but not discussed in the technical report. Or, is the difference in the numbers at the ADCP stations due to the difference in averaging time span because NA and NE do not have exactly the same deployment times?

5) I believe that the error estimates (Hansen et al., 2015) are a critical aspect of this work because it provides the context for interpreting the variability of the time series. The estimates in the technical report are sufficient and I believe they should be included in this manuscript. Furthermore, I think the error estimate in transport of ~ 0.5 Sv is similar to the 0.4 Sv RMS difference quoted in Section 3.3.1. This consistency should be noted in the manuscript as a quasi-independent double check on the error estimate.

6) Please explicitly interpret the significance of the trends in fluxes relative to the uncertainty estimates. The stated uncertainties nearly encompass the entire variability of each time series (e.g. ± 0.5 Sv is the vertical range of Fig. 6b). I interpret the relatively large uncertainties ($\sim 13\%$ for volume, $\sim 12\%$ for heat, and $\sim 15\%$ for salt, Hansen et al., 2015, page 48) to mean that there is an upward trend in the time series but the uncertainty in each data point is of the same order as the trend so the increasing trends are perhaps just barely visible.

Minor Comments:

Line 4: “intense” not “intensive”.

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Table 4: needs citations in table caption or in table rows.

Figure 1 caption: Please define both Atlantic inflows. Only one branch, over IFR, is listed and “FSC” in the bottom right of panel a is not defined or mentioned. Also, mentioning both inflows is necessary to be consistent with Table 4.

Section 3.2, line 16: This list of contributions is nice but a phrase or sentence is needed after the list to indicate which ones are being used.

Section 3.2.2, line 11 – j is used as a station index here while k is used as an ADCP position index and also an altimeter grid box index. It would help the reader if these indices were explicitly defined together at the same time, perhaps in the context of Fig. 2, and a separate index was used for each position type.

Section 3.3.2, line 23 “choices” instead of “choises”.

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