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Interactive comment on “Volume transport and mixing of the Faroe Bank Channel overflow from one year of moored measurements” by J. E. Ullgren et al.

Anonymous Referee #2

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Review of the manuscript: "Volume transport and mixing of the Faroe Bank Channel overflow from one year of moored measurements" by J. E. Ullgren et al.

General comments I agree with Refereree #1 that this manuscript presents an impressive data set and has some very important results but these results are based on an assumption, which is not well justified in the manuscript and I am not convinced that it is valid. I can therefore not recommend publication without major revisions.

The results presented are very important for our understanding of the role of Faroe Bank Channel (FBC) overflow in the global thermohaline circulation. In the simplest picture, FBC-overflow provides ≈ 2 Sv of $\approx 0^\circ\text{C}$ water, which entrains ambient waters of

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$\approx 6^{\circ}\text{C}$ so that the total contribution to NADW is $\approx 3^{\circ}\text{C}$. This implies that the overflow entrains similar amounts of ambient waters. Thus, if there is no detrainment, as claimed by Mauritzen (2005), then FBC-overflow should supply 3-4 Sv of overflow + entrained water to NADW. From the $\approx 1\text{-}2^{\circ}\text{C}$ warming of bottom water in Geyer et al. (2006), most of this entrainment should also have occurred before the downstream array (the S array) in the present study. Although this calculation is very much simplified and probably is an overestimate, we would have expected more than 2 Sv of water $< 3^{\circ}\text{C}$ through the downstream array (S array). But, Ullgren et al. report only 0.8 Sv. Instead of considerable volume transport increase due to entrainment, volume transport is substantially decreased due to detrainment. If these claims are supported, the impact of FBC-overflow on the THC is much less than what has usually been assumed. Unfortunately, I am not convinced that this is the only way to interpret the observational results, because they are based on an assumption that is not well justified in the manuscript. This assumption is that both mooring arrays (sections) cover the entire overflow plume. For the upstream array (C section), this is probably fairly correct although Figure 4 clearly shows overflow water to the left of (south of) mooring C3. For the downstream array (S section), this assumption is less convincing. This section is on the slope (Figure 2) and the moorings do not cover the deepest part of the channel. Thus, there is a priori no guarantee that the array covers the whole overflow plume, but the authors claim this (p.2319, l. 8-10 and p. 2335, l. 8-9). I have not found any arguments, on which they base this claim, but I assume that the main reason is the weak flow at S4.

From Geyer's (2006) Figure 3, we know, however, that the overflow plume splits into (at least) two separate branches. If the splitting occurs before the S array, then the weak flow at S4 could be because this mooring was located between the branches and the S array would not cover the whole of the overflow plume. The authors of the present manuscript are well aware of this branching (p.2317, l. 13-16), but they are apparently convinced that it occurs after their S array. That may perhaps be the case, but in view of the high-impact results presented, this has to be better justified. I have not been able to find observational evidence to support or reject this assumption conclusively,

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but Mauritzen et al. (2005) have a section (G section), which seems to run very close to the S array of Ullgren et al. On that section, Mauritzen et al. found overflow water below 1000 m depth (their Figures 23 and 24) and even two XCP profiles with bottom depths > 1000 m and core velocities exceeding 1 m/s (their Figure 25). Thus, it is not obvious to me that the basic assumption in this manuscript is valid.

In conclusion, Ullgren et al. need either to present more convincing evidence that their assumption is valid, or modify the analysis and results of the manuscript accordingly.

Details I have only a few details to add to those presented by Referee #1: 1) In the first line of the abstract, it says ten moorings. In the first line of Part 2, it says nine moorings. In Table A1 and the paper as a whole, there are 8 moorings. 2) On p. 2322, l.21-22, it says that time-average u-velocity reaches 94 cm/s at mooring S3, but that is not what you see on Figure 3c. 3) P. 2326, l. 27: Should "S2" here be "S3" ? 4) Caption for Figure 12: Have colours been swapped ? 5) Caption for Figure 12, first line: "aray" -> "array" 6) Caption for Figure 13, last line: "for for" -> "for"

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