

Interactive comment on “Arctic Mediterranean Exchanges: A consistent volume budget and trends in transports from two decades of observations” by Svein Østerhus et al.

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Reply to Referee # 1 (W.-J. von Appen)

Please find our answer to Referee #1 below. (A more Reader friendly PDF file is included as supplement).

Major comments: One thing that is probably an explicit choice, but does not always work, is that the authors do not consider any information provided about these exchanges by models. I have remarked in the minor comments below where at least a few sentences could be added.

C1

ANSWER Yes it is explicit Choice. We agree that compering our direct volume transport observations with information provided by models would add value to this paper, but we have deliberately chosen to give a conscientious description and analyses of our observations. However, in future works we will compare our observations with numerical models other observations to discuss our results in wider context. We have added a sentence in sect. 4.4: “. . . but will have to await future observational efforts for confirmation. Meanwhile our time series will be combined with results from numerical models, reanalyses (Bringedal et al., 2018) and observations using other methods (Rossby et al., 2018)”

I was a bit surprised that this recent paper which also brings together observational information from most of the same gateways discussed was not mentioned: Bringedal JCLI doi:10.1175/JCLI-D-17-0889.1 At least a reference to it and how those seasonal cycles and long-term time series agree and/or differ seems warranted.

ANSWER A reference to Bringedal et al. is added in sect. 4.4

There are many places in the manuscript (e.g. p1131, p413, p16115/23/29/30) where subscripts and superscripts were not converted correctly into the typeset version.

ANSWER corrected

Minor comments line by line:

C2

p1131 9.1+-0.7Sv What does the "+-" refer to? Is it the standard deviation? Of what? Please specify.

ANSWER The sentence has been reformulated

p1138 "At the 95% confidence level"

ANSWER Changed accordingly

p2129 and p9130 "en route" instead of "on route"

ANSWER Changed accordingly

p315 Somehow the grouping should be different. CAA should be separate from the combined outflow route of FS/DS.

ANSWER Changed to: . . . and leaves the AM through the Canadian Archipelago and Denmark Strait and the upper western Fram Strait as cold . . .

p417 "without yielding any information"

C3

ANSWER Changed accordingly

p5113 Many months have 31 days whereas February has 28 days in most years. Has this difference been taken into account? Or in order to arrive at an annual value, did you simply take the sum of (January average + February average + March average + : :) divided by 12?

ANSWER We have added a clarifying sentence to the beginning of Sect. 3

p5117 "but is deeper" Should it not rather be "shallower" or do you need a different conjunction than "but"?

ANSWER "but" has been changed to "and"

p711 "it seems clear" Why does it seem clear? To me it is not clear at this point.

ANSWER Deleted: "it seems clear that"

p10110 Are those 0.2Sv accounted for in the surface outflows?

ANSWER Part of this water, at least, is Atlantic water entrained into the overflow along

C4

its path from the Faroe-Shetland Channel into the Faroe Bank Channel. This is one of the problems more generally addressed in Sect. 4

p1119 Is “Canadian Arctic Archipelago” not a more common term than “Canadian Archipelago”?

ANSWER Changed to Canadian Arctic Archipelago (CA)

p1118 “mooring array north of the sill”

ANSWER Changed accordingly

p14122 “serial correlation” It is not clear exactly what is meant by that term. Please elaborate in 1-2 sentences.

ANSWER The word “autocorrelation” has been added and more text p14124 Consider “The exchanges between the AM and the Atlantic are therefore characterized by stability rather than change—at least over the observed period.”

ANSWER Changed accordingly

p16 While it is in principal mathematically correct to define τ_H and τ_Q and relate

C5

them to each other (equation 9), in my point of view, this is needlessly confusing. The more straightforward way would be to substitute \cos by \sin in equation 2 and to have the same phase τ_Q there.

ANSWER We have modified the equation to include the \sin version also, but kept the original (\cos) version as well, because we want to define the τ_H and show that $Q(t)$ is maximum 3 months ($T/4$) before $H(t)$ (Eq. (3))

p1730-32 What is “wanted” and “unwanted” water? Is not all of the water passing the sections water that passes the sections and therefore to be considered? Maybe I’m just confused by the terminology.

ANSWER This text has been modified to clarify the meaning.

p1815-7 Are you referring to non-linear effects of correlations between transport and water mass variability on higher frequencies than monthly (e.g. “eddy correlations”)? If so, it is not clear to me why this should be random and small. Rather this could introduce a systematic (rather than random) bias whose magnitude is not clear a priori.

ANSWER This argument has been deleted from the text here and elsewhere

p19120 This would be a good place to spend at least 1-3 sentences on what models have to say about this point. While your paper is observationally in its focus, you can at least refer to model results for hypotheses/speculation.

C6

ANSWER We have added a sentence to sect. 4.4 :

“... but will have to await future observational efforts for confirmation. Meanwhile our time series will be combined with results from numerical models, reanalyses (Bringedal et al., 2018) and observations using other methods (Rossby et al., 2018)”

p19I34 “in Fram Strait in some years”

ANSWER Changed accordingly

p21I6-7 “cannot have been caused” Also in light of your later sentence (p21I12-13) I think this statement is too strong. Given that changes in overflow properties (density in particular) can non-linearly lead to changes in the AMOC even for a constant overflow volume, you could point out that the overflow volume has not changed while you are not focussing on the other properties.

ANSWER The text has been modified to be more specific as suggested

p22I29 “: : : simultaneously. However, even : : :”

ANSWER Changed accordingly

C7

p23I2/3 Could you provide more complete links (not just the main website domain) or even more appropriately DOIs?

ANSWER We have added more completed data links.

p30I20 “trends that are significant”

ANSWER Changed accordingly

p33I7 “Grey areas : : :” On the shelf this makes for a humorous statement. I presume that was intended: : :

ANSWER yes

Fig8/Fig10 Both of these figures do not need a panel (a) and panel (b) which then have different spacings on the y-axis. Rather you could have a single panel with the y-axis ranging from -3.5Sv to 4.5Sv. This would make a visual comparison a lot less difficult. ANSWER This has been done (new figures 7 and 9)

Fig8 In this way, visually January and December are represented as half months while the other 10 months take up more space per month. This again makes a visual assessment of what is happening more difficult than necessary. Put another way, the line connecting December to January is missing while it is present (and occupying the

C8

visuals) for the other months.

ANSWER The figure (now Figure 7) has been modified accordingly and new Figure 8 has also been modified in this way

Please also note the supplement to this comment:

<https://www.ocean-sci-discuss.net/os-2018-114/os-2018-114-AC1-supplement.pdf>

Interactive comment on Ocean Sci. Discuss., <https://doi.org/10.5194/os-2018-114>, 2018.