

Interactive comment on “Circulation changes in the Amundsen Basin from 1991 to 2015 revealed from distributions of dissolved ^{230}Th ” by Ole Valk et al.

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Valk et al provide convincing evidence of decreasing ^{230}Th concentrations in the Amundsen Basin, which they attribute to increased scavenging over Eurasian shelves followed by transport of the water masses to the central Arctic. They use data from three different campaigns to show the ^{230}Th decrease between 2007 and 2015, and they support their explanation for the observed decrease with a model. The study presents important and novel results, but certain points in the text and figures should be clarified and condensed before publication. Specific comments are listed below. General comments: - Section 1.3.1: Instead of reviewing the previously published studies

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chronologically, it would be more helpful if similar studies were grouped together (i.e. the Moran 2005 and Hoffmann 2013 studies, which both focused on $^{231}\text{Pa}/^{230}\text{Th}$ ratios in sediments and came to similar conclusions about Pa export). This way the focus is on the results and current state of knowledge, instead of on the individual papers.

Reply: Yes we will change this organization of literature review in the introduction and we are confident that this will help to better understand the manuscript.

- Section 3.1: This results section is repetitive and should be condensed. Instead of listing the results by year, similar results could be stated in one sentence (e.g. “The depth profiles of ^{230}Th increased with depth in 1991, 2007, and 2015”, or, “Concentrations in the deep Makarov Basin were always higher than those observed in the Amundsen Basin”)

Reply: The result section has been condensed to half the original length.

- Sections 2.1 and 4.5: The Rutgers van der Loeff (2018) model provides support for the authors' hypothesis that the signal of increased scavenging over the shelves can be transported to the basin and propagated through the deeper parts of the water column. However, more details on the model would be appreciated in section 2.1, specifically regarding the exchange process used to introduce the ventilated water mass. Also, Figure 7 shows that after 8 years the ventilation signal does not reach below 3000 m. Can the authors comment on this difference between the model and data?

Reply: A description of how the model works will be added to the methods section. The model assumptions, such as particle sinking speed and exchange between dissolved and particulate phases might cause a difference between model and data, due to uncertainties. This may explain why the downward penetration of the ventilation signal is slower in the model than in the observed data.

- Section 4.6: The first sentence of this section states that the processes affecting ^{230}Th in the Makarov Basin could also provide an explanation for the changes ob-

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served in the Amundsen. The first hypothesis suggests that intermediate waters are advected from the Amundsen to the Makarov, and then the ^{230}Th concentrations are reduced by mixing. However, the ^{230}Th concentrations in the Makarov are higher than those in the Amundsen, so it is not clear how mixing with other Makarov basin water masses would reduce concentrations, and it is also not clear how this could provide an explanation for the decrease observed in the Amundsen Basin. Further, this section states that the salinities increased in the Makarov Basin, as opposed to the decrease observed in the Amundsen, which contradicts the first sentence of this section that suggests the changes are occurring through the same mechanism.

We intend to remove the whole Makarov Basin section because it does not contribute to the discussion.

- Figures 3 and 8 present the exact same data as figures 2A and 2C. I recommend that they be removed from the manuscript.

This will be removed according to the reviewers' suggestions.

- Title and last sentence of abstract: The title and abstract suggest that the ^{230}Th data indicate changes in circulation, but my understanding is that the decrease in ^{230}Th suggests increased scavenging over the shelves, not a change in circulation pathways. The changes in salinity indeed reflect a larger influence of Atlantic water, but the wording of the title suggests that the circulation changes are deduced from Th, not salinity. I suggest the authors consider a rephrasing of the title and/or abstract.

We will modify the abstract and the title accordingly to avoid the impression that circulation change was concluded from ^{230}Th data. The manuscript will focus more specifically on circulation change versus scavenging removal.

Specific comments: - Section 1.1 heading: "patters" should be "patterns" - Page 3, line 23 (Section 1.2): Please cite the reference that states that shelves make up 30% of the area of the Arctic. I am more familiar with the Jakobsson 2002 study (doi:

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10.1029/2001GC000302) that says shelves make up >50% of the area.

The 30% percent statement resulted from a misunderstanding. This will be corrected.

- Page 4, lines 7-8 (Section 1.3): Add the half-lives of the other Th isotopes here

Yes that will make sense.

- Page 5, line 13 (Section 1.4): Rephrase this sentence, as written it suggests that all of these processes are declining instead of changing (“: : ice cover is rapidly declining, as are changes in: : :”)

Yes it was misleading

- Page 7, line 3 (Section 3): Please briefly explain the excess corrections described in Hayes et al 2015, since this correction is important to the results presented here.

- ^{230}Th concentrations are corrected for a proportion of ^{230}Th released by dissolution of lithogenic particles. This is based on parallel measurements of ^{232}Th , considering a lithogenic ratio $^{230}\text{Th}/^{232}\text{Th} = 4.0 \times 10^{-6}$ mol/mol (Roy-Barman et al., 2009). We will include this in the revision.

- Section 3.2: A sentence should be included to explain the pink 2007 station 400 results if this data is shown on the figure.

This will be included in the modified manuscript.

- Page 8, lines 4-5 (Section 3.3): I am confused by the last sentence in this section, which compares the Amundsen and Nansen Basins. Because the particulate concentrations are not shown on the figure, please state the range of particulate concentrations in question (for both the Amundsen and Nansen Basins).

Reply: Particulate ^{234}Th from the Nansen Basin ranges between 1.4 and 3.3 % of total ^{234}Th above 1500m and below they range between 3.3 and 9.1% of total ^{234}Th .

- Page 9, line 6: Switch “generally” and “did” so the sentence reads “generally did not”

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Reply: Changed

- Page 10: Lines 1-2 and 5-6 are both stating that intermediate waters in the Amundsen had more Atlantic influence in 2015; these two sentences should be combined to avoid repetition.

Reply: Changed

- Page 10, line 19: Delete “water depth at” so the sentence reads “: : concentrations are 8.23 fg/kg at 1000 m and : : :”

Reply: Changed

- Page 10, line 25: This sentence references increased inputs of terrestrial matter and increased primary production; what increase is being referred to here? An increase compared to earlier years?

Reply: A general increase of terrestrial input compared to previous years is mentioned here.

- Page 10, line 27: Are the high concentrations of Fe at the margin or in the basin?

Reply: Concentrations at the margin are meant here, this will be stated explicitly.

- Page 10, line 28: Instead of saying “: : : the deep water is in the fluence of BSBW” I suggest saying “deepest water”, because the depth of 1200 m is relatively shallow compared to the other stations.

Reply: We agree and change the text accordingly.

- Section 4.6: The heading for this section may be missing a word, it does not make sense as written.

Reply: We think the Makarov Basin section should be removed.

- Page 12, line 9: I suggest deleting this sentence and putting the figure references at the end of the first sentence instead.

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Reply: This will be changed accordingly.

- Conclusion: I find the conclusion well-written and a good summary of the paper.

Reply: Thank you.

Figures: - Figure 1: Please include stations from the Makarov Basin that are referenced in the study.

Reply: We will include those stations.

- Figure 1: The Gakkal Ridge (GR) is not defined in the caption, and is not visible with the chosen color scale.

Reply: Both have been changed now.

- Figure 2: Figures 2C and 2F are from the Makarov Basin while all the other panels are from the Amundsen. I suggest making panels 2C and 2F a separate figure, or at least putting them next to each other (by switching panels 2C and 2E).

Reply: If the Makarov Basin section had remained in the manuscript, we would have structured the figure in a more logical way as proposed, but in line with suggestions from both reviewers this section will be removed.

- Figure 2: If the stations on Figure 2E are numbered, there is no need to plot them in different colors. It would be easier to follow if they were all blue (to indicate data from 2015), and the different symbols used to denote the station numbers in panels A and B could be continued in this panel.

Reply: All 2015 stations can now be identified by their blue colour.

- Figure 2: It is confusing that one station from 2007 is plotted in pink and another in green. The pink data were collected close to the margin, while the green station was in the Amundsen Basin. The pink data therefore make it difficult to discern the trend of decreasing Th in the basin that is the focus of the study, and they are also

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not explained in the caption for panel A. Instead of having two labels that say “2007”, I suggest specifying “2007, margin” and “2007, basin” for the pink and green stations, respectively, to make the basin trend more clear.

Reply: The label has now been changed to 2007 margin station.

- Figure 2D: Move the 2015 label beneath the other labels, so it is easier to find.

Reply: Changed

- Figure 2F: Are the red/orange stations from 2015? The 2015 year label is missing.

Yes they are. The label has been added.

- Figure 4: The x-axis should be at the top of the plots, consistent with the other depth profile figures.

Reply: We changed it accordingly.

- Figure 5: I think a period is missing after the first sentence of the caption (between Amundsen Basin and BSBW)?

Reply: Yes it was missing and has been inserted now.

- Figure 6: It would be helpful to keep the symbols and colors the same between panels A and C.

Reply: Yes, we agree and will change the colours accordingly.

- Figure 8: The caption is incorrect (should be Makarov Basin not Amundsen Basin). Interactive comment on Ocean Sci. Discuss., <https://doi.org/10.5194/os-2019-49>, 2019.

Reply:, that was wrong and has been changed now.

Interactive comment on Ocean Sci. Discuss., <https://doi.org/10.5194/os-2019-49>, 2019.

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