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# *Interactive comment on* "Using $^{226}$Ra and $^{228}$Ra isotopes to distinguish water mass distribution in the Canadian Arctic Archipelago" *by* Chantal Mears et al.

**Michiel Rutgers van der Loeff (Referee)**

mloeff@awi.de

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The paper presents and discusses the results of a study of long-lived radium isotopes in the Canadian Archipelago as part of a larger GEOTRACES study conducted 2015-2016 in the Arctic Ocean. The study is supported by parallel analyses of Ba and of the carbonate system (DIC, AT). The chemical and hydrographical data are subjected to a principal component analysis and the results are used to derive apparent water mass endmembers. The general features are well explained by 228Ra releases from (especially southern) shelf regions, a separation of water masses by the pycnocline (at about 100m depth), an eastward outflow of water from the Canada Basin over the sill in



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Barrow Strait (less than 200m deep), and an anticlockwise recirculation of water from the Baffin Bay through the Lancaster Sound.

Graphs are very clear but a few are in my view not necessary for the message. Unless a clearer reason is given for the need for the normalization of DIC, Figs. 5 b and c can be omitted. Figs. 13 b and c do not add to the information given in Fig. 13a.

This paper adds an important chapter to the distribution and behavior of Radium isotopes and their use as water mass tracers in the Arctic Ocean. It deserves publication in Biogeosciences after a minor revision. It is generally well written, but there are several paragraphs that should be clarified.

Specific comments: 101: “westward” or eastward? 122: “nearly conservative”. You might mention that there is a certain uptake (with Ba) by primary production 135: why is salinity called Sp? Why not just S as usual (and as used in eq 2)? 218: I understand that 228Ra was also regressed against salinity to derive the endmember value at S=25. 233: “similar results”. It is not clear whether these authors found similar east-west gradients or similar exceptions to that rule as the example of CAA3 and CAA5. 251: I do not find CB4 results in Fig 2

246-256: this paragraph is too condensed to be understandable. I would like to see a bit clearer formulations. 246-247: For the intercept values of AT and DIC versus salinity, refer to Figs. 4 and 5a. I understand that the intercept in DIC is used later for the normalization of DIC. That makes it important to show the regression lines and indicate the error of the intercept values. 248: “thus attributed” I don’t understand what is meant here 253-255: “similar results”? With respect to longitude yes, but without the metabolic maximum 254: “both”? 255: do you mean that at the depth of the pycnocline both S and AT but not DIC are increasing eastward?

Lines 263-274; Normalization of DIC: I understand from Friis et al. (2003) that normalization is meant to remove the salinity dependence of DIC, which is apparently not the result here (compare Figs. 5 a,b). The rationale of this normalization is not well ex-

plained. The difference between surface and subsurface water masses is clearly seen in Fig. 5a (especially when in panel a the symbols belonging to anomalous station CB4 are marked as they are in panel b and c) and is not made clearer by the normalization procedure depicted in Figs 5b and c. 272: “consistent” is misplaced here. The inverse longitudinal trend is noted in the next sentence, but it is not explained why the accumulated DIC decreases “as waters flow longitudinally eastward through the CAA”. When surface water flows eastward, DIC increases, S increases and DICnorm decreases. Is this the non-conservative behavior meant in line 266 to be shown by the normalization (evasion of CO2?) or just an effect of mixing with high-S/low-DICnorm water from Baffin Bay? 363: why does the similarity of Stas CAA1, 3 and 5 to the Deep ATL group suggest a westward intrusion along the northern edge when Stas 1 and 5 are along the northern edge but Sta 3 is along the southern edge?

380: Explain why you show in Fig. 11d the 226Ra/Ba ratio and not 226Ra itself. Why is the scale in Fig. 11c inverted? That is a bit confusing.

Lines 386 and further; Figure 13: It is very useful to plot 226Ra vs Ba and to map the 226Ra/Ba ratio. But what is the advantage of plotting the ratio against each of its components 226Ra and Ba (Figs 13 b,c)? In 13a, what is the broken line? If this is the relationship found by Le Roy (and/or van Beek), then mention it. If not, then include it. What are the circles? They are missing in panel13c. The red symbols (S>34) in Fig. 13a appear to show that 226Ra is independent on Ba, in contrast to the findings of LeRoy and van Beek. In line 391 you may mean that the average position of the red symbols ($\sim$10 dpm/100L; 44 nM) falls along that line, but their 226Ra variation is not associated with a corresponding variation in Ba.

396: Please give a reference for the high Ba runoff of rivers draining into the CAA.

Lines 476-509; Figure 12: What is the meaning of the broken line in 12a? Is that the relationship based on apparent endmembers? Perhaps this is related to the expressions “higher” and “lower ... than the mixing ratios” in lines 487-494. Please





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clarify. The symbols in Figs.12 a,b appear to have no other background than their position relative to each other on this graph. It is then more appropriate to use an enveloping ellipse as in Fig 9 rather than different symbols. It might be interesting to identify the outliers geographically (in Fig 12 c). Legend: flow paths? The figure is discussed again in lines 503-509, but that formulation must be improved. Line 502: you mean: the 228Ra/226Ra -$\delta$18O relationship (Fig. 12b). If you want to show non-conservative behavior from this relationship, shouldn't you draw an endmember mixing line as in panel a? Line 503-505: I guess you mean that conservative mixing of 228Ra or 228Ra/226Ra with a pure riverine source can be excluded, but that will hold for a plot against salinity as well as for a plot against 18O.

FIGURES: Fig. 7: make sure that the names of all the parameters are readable. "18O" is covered. Fig 14: Is this surface flow? If not specify at what depth.

Michiel Rutgers van der Loeff, 15 April, 2020

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