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Interactive comment on "Evolution of ^{231}Pa and ^{230}Th in overflow waters of the North Atlantic" *by* Feifei Deng et al.

Anonymous Referee #2

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Here Deng et al. provide a very nice and concise piece of science. They examine crucial assumptions made for the application of 231Pa/230Th as an AMOC proxy by providing an extensive new data set of water 231Pa and 230Th concentrations. This is hard won data and the authors deserve credit for their efforts. The new data extends the former GEOTRACES transects by Hayes15 and Deng14 towards the northern North Atlantic representing a definite reality-check for the assumptions made when using 231Pa/230Th as a proxy. These assumptions have been made based on the elegant approach of measuring a kinetic tracer with a constant and well-defined input-function not involved in the carbon-cycle (Yu1996). While previous studies already proofed the consistence and capability of 231Pa/230Th as an AMOC proxy the novelty of this study is the systematic examination of the behaviour of 231Pa and 230Th in the

northern North Atlantic in the water masses recently influenced by NADW formation with a new set of samples and by state-of-the art analytical methods. Therefore, this manuscript certainly deserves publication in Biogeosciences.

Given the published results from the 231Pa/230Th proxy of the last decades I would have wondered if this study would have come to a different conclusion. But here Deng et al. make very good cases by confirming the prerequisites for using 231Pa/230Th as AMOC proxy. The only little weakness of the manuscript is the missed opportunity of setting the new findings into the context of the attempts of using 231Pa/230Th as a large scale AMOC proxy. There are several of papers dealing with a single 231Pa/230Th profile from on location, but the results of the few which deal with comprehensive compilation approaches could be better assessed and discussed here. Besides the already mentioned Yu et al. 1996, I think in particular of Bradtmiller et al. 2014, which use the large scale 231Pa deficit for analyzing the HS1 AMOC. It would be worth of shortly recapitulate their results in the light of the new results presented here. Besides the connection to observational paleo data I also miss the comparison to theoretical or model studies. The authors should in particular present a short comparison to the predictions made by Marchal et al. 2000 and the most recent attempt by Rempfer et al. 2017. Further, most of the features reported here have been anticipated by the simple box-model approach by Luo et al. 2010. They already found a very weak correlation of 231Pa/230Th with water mass age, highlighting a vertical gradient not a horizontal in the presence of an active AMOC (see specific points below).

page 3, line 2: recurring typo of "R/V Pourquoi Pas?"

page 3, line 15: please specify how many several months are

page 3, line 19: what was the analytical yield ($\sim$ range)of the anion chromatography for Pa and Th?

page 3, line 25: what was the 232Th/231Pa in the Pa-samples? Was the correction for the 232ThH interference necessary, if yes, how big was the contribution to the Pasignal?

page 5, line 14: ISOW is mentioned but not shown in Fig. 5.

supplement: please add a column specifying the errors to the given concentrations

supplement page 7 line 7: I'm aware that this is of marginal importance given the final result, but maybe the authors could elaborate on the value 0.7 in (3) and (4). 0.7 seems a little bit high for an average, or at least unnecessarily high at the high end of the possible range according to Henderson and Anderson 2003 or Bourne et al. 2012. Further, is the detrital correction required for particles slipping through the 0.45 μm filters? Is the added HCl capable of leaching of the 232Th (and 230Th and 231Pa) from these particles?

Fig. 3,8,9: error bars are misssing

page 7, line 21: It is not surprising that 231Pa/230Th does not correlate with water mass age very much. This has been already predicted by Luo et al. 2010. Much more important is the vertical decrease within one circulating mater mass (e.g. Burckel et al. 2016). Thus, the sentence that "231Pa/230 ratios increase as water mass ages forms the foundation of using 231Pa/230Th in discrete cores" is not completely accurate.

page 10, line 13: typo. two times "demostrates".

Fig. 6 : I assume the x-axis has changed between (a) and (b), but they are both shown on the same longitudinal scale.

Fig. 3: maybe it would be worth of showing 231Pa/230Th as well in an additional panel (c). Fig. 8: please indicate water depth at the colour bar.

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